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ABSTRACT

A computer managed instructional system for reading, begun five years ago in Belvedere-Parkway Elementary School in Calgary, contains 329 behavioral objectives ranging from kindergarten to 8th grade levels, with testing performed online. After completion of a test, a student receives a printout listing the objectives completed, those that need revision, and those that remain to be learned. Class reports show student performance by objectives, and provide specific prescriptions for each student related to the reading texts used in the school. Results show that teachers, students, and parents have all benefited. Teachers are freed from administering, scoring, and recording tests, and can use the prescriptions to plan individualized instruction. Students are motivated by the positive statements about their progress which appear on their individualized summary sheets together with the objectives which still need work. Parents are pleased because they know, from the summary reports, where their children are in relation to what is expected. In addition, reading achievement scores for 6th grade students have increased from the 25th to the 55th percentile. Copies of the student summary sheet and the summary report are included. Additional details are provided in the attached paper by the same authors. (BK)

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TEACHING ELEMENTARY READING BY CMI AND CAI

by

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ABSTRACT

A computer managed instruction system used in conjunction with the reading program at an elementary school is described. It contains tests on 329 behavioral objectives ranging from Kindergarten to grade 8 levels. After the completion of a test a student printout gives objectives known, those needing revision and those to be learnt. Class reports showing student performance by objectives also detail specific prescriptions relating to reading texts in use in the school. Results obtained over a five year period are described, and future expansion plans are discussed.

Introduction

Various practices in use in the educational system today, such as promotion by age rather than ability and the integration of the handicapped into the normal schools, bring together groups of students with widely differing abilities and achievement levels. Teachers faced with educating such heterogeneous classes must introduce some small group or individualized instruction. While there is little opposition to the idea of such instruction it is rarely carried out on a wide scale due to the size of the practical difficulties involved.

There are two major problems. The first of these is to gather and arrange in a logical sequence sufficient varied learning materials on which students can work individually. The second problem relates to individualizing the use of these materials and includes assessing each student's strengths and weaknesses, prescribing appropriate learning materials and monitoring the progress of each student in the class. The latter problem, however, can be greatly alleviated by the use of a computer management system which performs routine testing and record keeping tasks.

The Reading Materials

Several years ago a committee was formed in Belvedere-Parkway Elementary School in Calgary to attempt to develop an organized group approach to individualized instruction. Priority was given to the area of reading.

Many sets of materials and different approaches to the teaching of reading skills were considered. It soon became obvious, however, that it was necessary first to specify a continuum of skills that was sequential from kindergarten to Grade 8. Further, it was realized that some of the programs available needed far larger amounts of resource materials than were practically manageable in the school.

After several months of investigation it was decided that materials developed by the Educational Development Corporation (1973) most closely met the school's requirements. These materials related to a continuum of skills, defined in behavioral terms, and were compatible with the Calgary Board of Education's listings. They included a diagnostic testing program, a prescription service, and teacher support materials. Further, many of the latter were already available in Belvedere-Parkway School.

Having obtained the necessary learning packages, the problem of how to bring them into use was addressed.

Since an essential part of a reading skills program is continuous monitoring, pacing and evaluation with testing, diagnosis and prescription occurring throughout the entire school year, it was apparent from the beginning that an efficient management system was needed. Hence the present research project, namely a computer managed instruction program in reading, was initiated by a team from the Computer Applications Unit of the University of Calgary's Faculty of Education, the Calgary Board of Education Research and Testing Department, and the Belvedere-Parkway School committee.

The criterion referenced tests provided by the Educational Progress Company are designed for Kindergarten to Grade 8, and consist of 329 behavioral objectives which are tested in 44 booklets. Each booklet contains two questions for each of the objectives, and most have 16 questions, thus testing 8 objectives. There are two sets of the tests, one of which can be used as a pre-test and the other as a post-test, giving each student four attempts at each objective. This provides the teacher with a performance picture of the individual student.

The Computer Management System

A computer management system was written in the BASIC-PLUS language for the DEC 11/70 computer operated by the Computer Applications Unit. It incorporates three main file structures. The first contains the answers to the questions in the criterion referenced tests, another has a record for each student in the school, and the third file holds the prescriptions. Two smaller associated files contain lists of teacher names and objectives. The system is accessed by terminals in the reading area of the school using acoustic couplers and the standard telephone network.

The day-to-day running of the management system is carried out by an aide, whose duties include entering all student names into the student file at the beginning of the year, registering those who join during the year and deleting the records of those who leave, monitoring the testing of students, and obtaining reports for the two teachers responsible for the reading area.

Testing is usually done on-line. When the student's name is entered, the system accesses the appropriate record on the student file and prints out the number of the next test booklet which the student should complete. In the case of students working on the system for the first time, the booklet number is estimated by a reading teacher. Also a supplementary program is available to these students which will guide them through a series of steps to ensure they fully understand the testing procedure.

The student then reads the multiple choice questions from the booklet and types the answers on the terminal keyboard. The program scores these replies and stores the results for further analysis. Testing continues until a twenty-minute session has been completed on the terminal, or until a choice is made not to proceed further, or until the "approximate working level" of the student is reached. This level is defined as the last correct response beyond which the student gives five successive incorrect answers.

At this point the student summary report (Figure 1) may be obtained. It lists the objectives mastered (both answers correct), those which need to be reviewed (one answer correct), and those which must be learned (both answers wrong). These student summaries provide very useful teacher-student conference material.

When testing sessions have been completed for all the students a class summary (Figure 2) is available. This groups the students by objective into three sets. First those students who know the objective are listed, then the students who need to review the objective, and finally those who need to learn the objective.

For each of these three sets of students the class summary also lists a variety of prescriptions. This is a most important part of the management system in that it indicates in detail the precise parts of the reading instructional materials to which each student should now proceed. All prescriptions refer to texts used and available in the school. For every objective a prescription exists for three sets of teaching materials thus allowing for teacher or student choice, and also ensuring that supplementary material will always be available.

A final report available is a school summary which lists the reading performance of the students by objective. This performance rating indicates first the number of students who need to learn, then those who need to review, and finally those who know the objective. The report provides a reading performance level by grade and objective for the entire school and is used by the administration and library services.

Results

The management system has now operated for more than five years with a minimum number of technical problems and has been very well received by

teachers, students and parents.

For the teacher there are a number of benefits from the program. Such routine tasks as administering and scoring tests, recording results, assessing, prescribing according to this assessment, grouping the students for instruction, and re-testing as the need arises are all carried out automatically by the computer management system. A further important benefit is that the prescriptions are available and grouping can be done when the test results are still relevant, rather than some time afterwards when the results are already becoming outdated. Teachers are not told how to teach the children, but are given individual assessments and groupings which may be used in conjunction with their own informal assessments and observations. They are therefore relieved of many clerical tasks, and so gain pupil contact hours.

The teachers find an additional advantage over and above the use of the computer printouts in the classroom, namely, in reporting student progress to parents. The printouts provide an excellent basis for both interviews and report cards.

Corrective reading teachers continually update reading prescriptions, replacing those which are not meeting the student or teacher expectations. A series of back-up remedial materials for all the objectives has been developed and is maintained by the corrective reading team. These materials are readily available to all teachers in the school.

All students see their own student summary and invariably accept the printout as an accurate statement of their skills. Moreover, they always receive at the top of the summary a positive statement of the form: "You have a good understanding of the following objectives". In over five years of operation, only one student has ever failed to receive this statement and, with

it, quite positive encouragement. This motivates students to read the report further, to look at their needs and to improve their reading skills. This motivation had not been anticipated, and is an incidental but invaluable benefit from the program in developing students' reading skills.

The parents are particularly interested in seeing the report produced by the management system. From the computer printout they now know at reporting time exactly where their child is in relation to what is expected in that year's reading program.

One way in which the success of the program can be measured is by examining reading test results. Since the program was implemented these have improved considerably. On city-wide tests the mean performance of Belvedere-Parkway School Grade 6 students used to be at the 25th percentile. It has gradually increased until it is now at the 55th percentile.

Although these achievement results are important, the attitude change brought about by the program is more significant. By directing the student's attention to those items that require review and need to be learned, the individual reports save time and energy. Moreover, the recognition of the objectives that the student understands supplies a reason to use what has been learned, and to learn more. This factor has increased library usage, and the quality of all reading-based work.

Students from Belvedere-Parkway School proceed to a local junior high school. Teachers from this school confirm that there has been a significant improvement in the attitudes towards school and learning among students from Belvedere-Parkway School. They now frequently send junior high school students for testing and prescription by the computer management program.

Other schools both within Calgary and in other areas of the Province are interested in the program. The reading teachers frequently demonstrate it to personnel from other school districts, while within the city it has been used by several schools on a trial basis.

Three years ago all 400 students in a neighbouring elementary school were tested by the Belvedere-Parkway reading staff, who provided a diagnosis for each student by means of individual student summaries, also class groupings and prescription listings.

The Calgary Children's Hospital School consider the system particularly suitable for their students, many of whom are handicapped and in need of individualized attention. An in-service workshop was held for the teachers in the hospital school, while teachers in another elementary school are currently learning how to use the system, and within a few months will be operating it for all their students.

Board members and teachers from the Calgary Separate School Board examined the management program in operation and were impressed with the capabilities. Having decided to try it on a small scale before actually implementing it in a school, they bused 13 students from a special education class to Belvedere-Parkway School for testing and assessment.

With class loads increasing and integration of handicapped children into regular school classes becoming a reality, teachers and administrators face not only heavy teaching assignments but a great diversity of student abilities within one class. Computer technology has much to offer in five solving these problems: Belvedere-Parkway School has found, from over five years of experience, that computer managed instruction does lead directly to individualization which in turn leads to better achievement and improved attitudes towards learning.

Conclusions

Stemming from the success of the initial project various other computer based learning activities are either being implemented or are in the planning stage.

The reading teachers are examining the objectives and changing them to better meet the needs of the local students. They are also examining statistics on the test questions and replacing those that are ambiguous or do not test the objective adequately.

Computer assisted instruction modules are being developed, and some have already been tested and are in regular use in the school. These cover the topics of syllabication and roots and affixes (Wontner, 1978), and plural forms and possessives (McIntosh, 1978).

Also, since the number of terminals in the school was increased from three to five in September, 1979, it is now feasible to consider the running of a further computer management system for arithmetic skills. It is planned to implement such a system in the near future when a suitable set of objectives, tests and prescriptions has been identified.

In summary a computer management system for reading skills has proved very successful for both students and teachers at elementary school level. It is being expanded to include computer assisted instruction modules, and a further management system is planned for the learning of arithmetic skills.

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Wontner, C. A Study of the Effect of Using Computer Assisted Instruction for Teaching Vocabulary Skills at the Grade Six Level. Unpublished M.Sc. thesis, University of Calgary, 1978

McIntosh, Esther. CAI Programs on Plurals. Unpublished paper, University of Calgary, 1978.

FIGURE 1

Student: 1051 September 1979
HERMAN LUK

STUDENT SUMMARY

YOU HAVE A GOOD UNDERSTANDING OF THE FOLLOWING OBJECTIVES:

234 Select short vowel word to complete a sentence
238 Define an unfamiliar word by selecting a synonym
241 Identify a phrase to complete a sentence by using context clues
242 Identify a word to complete a sentence by using context clues
243 Identify the definition of a word with multiple meanings by using context clues
247 Select a phrase that answers questions about an unfamiliar passage
257 Identify a word completing a statement about similarity or difference between characters in a story
262 Identify the purpose of a passage: to persuade, to inform, or to entertain
264 Classify phrases: describing actions, forming visual pictures, denoting sounds

YOU NEED TO REVIEW THESE OBJECTIVES:

236 Identify the root of an affixated word, (un*know*ingly)
237 Define correctly an affixated word
244 Match a word with multiple meanings to all its definitions
245 Identify key words in skimming a passage
246 Identify a sentence that means same as given sentence but has different functional units
251 Identify features that do or do not relate to a class of things
253 Identify a sentence which rephrases the main idea of a paragraph
254 Identify the phrase which completes the implied cause-effect relationship
255 Identify an implied statement best supported by information in a passage
256 Identify a conclusion supporting or not supporting details in a passage
258 Select the correct word or phrase to complete a sentence in a familiar passage
259 Identify a word that completes a sentence comparing characters in a story
261 Identify the best description of an author's intent
265 Identify statements of fact and opinion

YOU NEED TO LEARN THESE OBJECTIVES:

235 Syllabicate a three-syllable word

239 Identify an antonym

240 Identify a word for completing a sentence by finding its definition within the sentence

248 Identify time passed in a passage containing clues about time

249 Identify the statement making a logical inference based on a story

250 Identify a sentence which does not support the main idea

252 Identify a sentence which rephrases the main idea of a passage

260 Identify a sentence that summarizes a paragraph

263 Identify the emotion described in a passage

FIGURE 2

Room 55 Test # 277-Obj# 256 September 1979

IDENTIFY A CONCLUSION SUPPORTING OR NOT SUPPORTING DETAILS IN A PASSAGE

	A.R.P.L.[1]	OPEN HIGHWAY[2]	.R.A.[3]
BOTH ITEMS CORRECT	6-6B	6:83*124*153	[4]IDC:Books D*E*
Allen Lisa			
Brandt Angela			
Gray Fredrick			
Ho Sally			
Johnson Richard			
Kelner Charles			
Mann Susan			
Mason Margaret			
Patterson Brian			
Sordi Wendy			
Vallence Charles			
Wong Chun-Chi			
ONE ITEM CORRECT	A.R.P.L. 5-9A	OPEN HIGHWAY 5:48	.R.A. IDC:Books C*D*
Carnduff Emily			
Lee Robert			
Muir Ken			
Warren Joan			
NO ITEM CORRECT	A.R.P.L. 5-9A2	OPEN HIGHWAY 5T:1[illegible]7/5:30*48	.R.A. IDC:Books B*C
Chan Henry			
Stotyn Dennis			

1. A.R.P.L. = Audio Reading Progress Laboratory
2. Open Highway = Reading Text series
3. .R.A. = various reading activities listed in 4.
4. DC = A Barnell Loft reading booklet on "drawing conclusions"

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AN ELEMENTARY SCHOOL DIAGNOSTIC READING PROGRAM BASED UPON CMI

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1. A SIX-YEAR PROJECT

A project to provide a diagnostic reading program based upon a computer management system has now been operating for six years in a local elementary school on a co-operative basis between the University of Calgary Faculty of Education Computer Applications Unit, the Calgary Board of Education, and the staff of the school. The initial stages of the project were reported in a paper at the Second Canadian Symposium on Instructional Technology (Brebner et al, 1976). Since that time the CMI program has developed significantly, it has met with general acceptance in the school and in the local community, and there have been notable improvements in the mean reading scores of the students in the school.

The success of the project has led to its use in nearby schools, to the development and use of CAI programs to teach reading in the school, and to the present extension of the management system to include number skills. It is therefore considered to provide a case study of the gradual development of a system of computer managed instruction, from research to practical application, in a public school setting.

2. OBJECTIVES

The elementary school in which the project operates is situated in a disadvantaged area of Calgary. In 1973 there was widespread concern regarding the low levels of achievement in basic skills in the school, and a recognized need for action to improve them. The concern was with regard to both reading and number skills; however, it was considered advisable to pay special attention to the former in the first instance.

The obvious solution was to provide more individualized attention in order to meet the unique needs and difficulties of each student. This presented to the staff of the school the two sets of problems inherent in every attempt to individualize instruction: the provision of an adequate supply of effective learning materials, and the implementation of a management system to ensure the individualized learning operates smoothly and without too great a burden on each teacher.

A related problem, from the standpoint of the school administration, was to arrange the introduction of an individualized system so that it would be accepted by all the relevant constituencies: the students, the teachers, and the parents. This was essential if the program was to become an integral part of the teaching in the school.

Central to the solution of these problems were the two specialist reading teachers in the school. They were responsible for much of the organization of the courseware and the specification of requirements for the management system. By taking university courses they made themselves into efficient computer programmers, and became familiar with both CMI and CAI applications. They acted in a liaison capacity between the school and the Computer Applications Unit, and undertook responsibility for the administration of the system in the school and its explanation to members of staff and teacher aides. Further, by themselves becoming active in research, they helped ensure the continued development of the project.

3. LEARNING MATERIALS

The learning materials needed for a reading skills program were considered to consist not only of the appropriate texts but, even more important, diagnostic measures covering major skills involved in reading. It was necessary to use criterion referenced tests in order to assess the strengths and weaknesses of each student and, on this basis, to provide a prescription listing specific texts which could be used to remedy deficiencies, consolidate present skills, or provide enrichment.

It was decided to make use of the criterion referenced tests produced by the Educational Development Corporation (1973) and, on this basis, to develop prescriptions referring to reading texts already available in the school. The tests consist of 329 objectives which are contained in 44 booklets designed for use from Kindergarten to Grade 8. They range from the first objective, identifying words containing a, e, i, o and u (K); through objectives relating, for example, to beginning sounds and ending sounds (Gr 1), identifying the correct form of an adjective to complete a sentence (Gr 3), or selecting a phrase or sentence that is a clue to the meaning of an unknown word (Gr 6); to identifying evidence to support a hypothesis (Gr 7), and paraphrasing a written passage (Gr 8).

Most test booklets contain two questions for each of eight objectives. There are two sets of booklets: if Form A is used as a pre-test, and Form B as a post-test, each student has four attempts at each objective. Students who complete two items correctly on an objective are considered to have mastered that objective; students with one item correct are required to consolidate their knowledge on that objective; while students who fail both items are referred to materials to teach the skill.

The references to reading texts available in the school were developed by the two specialist reading teachers. For each objective, and for each of the three levels of achievement on that objective, references were listed to at least three sets of reading materials.

It was therefore possible to test a student using an appropriate range of the 329 objectives and, on the basis of the results, to provide a prescription to meet the individual needs of that student in terms of his achievements and deficiencies in a specified set of reading skills.

Without a computerized system, it is not uncommon for a teacher to give a diagnostic reading test to a class of students at the beginning of the school year, only to discover that it is impossible to both score the test and devise a prescription for each student whilst the results of the test are still valid.

4. THE CMI SYSTEM

It was therefore necessary to develop a computer management system to score the test, provide the prescriptions, and maintain a record of each student's progress.

The first version of the CMI system operated on a DEC TSS-8 computer in the Computer Applications Unit, with two terminals in the school. The present version, which has now been in use for three years, uses the DEC 11/70 computer in the Unit.

Five terminals are now in use in the school, of which four are CRT terminals for use in testing of students, and one is a hardcopy terminal for obtaining printouts for the teachers.

The system consists of three main sections: the test section used by the student or an aide; the report generation section which produces a variety of detailed and summary lists; and the editing section which enables the teachers in charge of the system to enter information into the three data files relating to student records, tests, and prescriptions.

Students may answer the multiple choice test questions by marking answer sheets or by using a terminal on-line to the computer. In either case, the starting point is determined by the student's previous history or by a teacher judgment of the student's level. Testing continues until a student fails five successive tests, or for a period of 20 minutes, whichever is the shorter time.

Of the 520 students in the school, all except those in Kindergarten answer the tests and are provided with prescriptions. This means that 475 students from Grade 1 to Grade 6 use the system, although those in the first grade are not tested until the end of the school year, in June, when most of them are able to read. Grades 2 to 6 are tested three times a year, in September, January, and May. These tests are given by the two specialist reading teachers to one classroom group of students at a time. It is considered important that group testing should be done by the specialists, rather than by the classroom teachers, in order to obtain consistency of procedure and help ensure validity of results. Students record their answers

in pencil on prepared test sheets and the data are later entered into the computer by aides using the CRT terminals. At peak testing periods four aides are employed on this task and are very fully occupied.

At other times of the year, new students arriving in the school take the tests individually at a computer terminal. Students who are fast or slow learners may also be retested, in the same manner, at any time. In this way an attempt is made to provide further for individual differences: any student who is identified by a classroom teacher or by a specialist reading teacher as needing a new prescription may be tested and provided with one immediately.

No differences have been noted between the two methods of testing and the use of one procedure or the other is simply a matter of logistics and, ultimately, cost. There is every reason to conclude that, as computer time and terminals become less expensive, there will be a continued trend towards more individual testing, also towards more frequent testing.

When the five terminals are not required for testing they are used for CAI. All are in operation daily, from 7.00 a.m. until 3.30 p.m. Since the two specialist teachers are also responsible for teaching two classes of students needing corrective reading and enrichment, the terminals are for much of the time under the immediate supervision of the aide. However, responsibility for the operation of the terminals and the programs rests with the two specialist teachers. This is considered a crucial factor in maintaining the credibility of the system among the staff of the school.

5. REPORTS

The long term credibility of a CMI system depends in large measure upon the reports it can provide, and the manner in which they are used. These are the factors which determine what changes in student achievement, if any, a CMI system effects in a school as it is put into practical operation.

Like most CMI systems used in schools, the present system can provide reports of three main types: for individual students, for groups of students (in this case classroom groups), and for all students in the school who are registered on the system. Due to the work of the two specialist teachers, these reports are now accepted and used effectively by teachers, students and parents.

1. Individual Student Report

The report for an individual student consists of three sections, each addressed to the student in person. These are headed, respectively: "You have a good understanding of the following objectives"; "You need to review these objectives"; and "You need to learn these objectives". Following each heading there is printed a list of objective numbers, each followed by a one line description of the objective, e.g.

238 Define an unfamiliar word by selecting a synonym

245 Identify key words in skimming a passage

The report covers all objectives on which a student has been tested. It begins by listing the student's strengths in order to give positive reinforcement. Nowhere does it mention failure: rather, it is a statement of learning which must be consolidated, and goals which must now be achieved.

This report is used in teacher-student conferences. In this connection, it is considered important that the report is addressed directly to the student. The teacher is merely an advisor: the student is told, by the computer, what work needs to be done. This has proved a good source of motivation: results are accepted as being impartial, and students are more inclined to accept responsibility for their own improvement.

The individual reports are also used by teachers when completing report cards, and when interviewing parents. They provide up-to-date and objective information, and are highly regarded by parents. In effect, these individual reports both ease the work and enhance the professional reputation of the teachers. The staff of the school now regard them as one of their important resources.

A copy is always placed in the student's cumulative record file, which may then be used to trace a student's progress in reading

as he proceeds through the school.

2. Class Report

The class report may be obtained by a teacher at any time. It gives the number and name of every objective tested for the class. For each objective, three categories of students are listed by name: those who completed both test items correctly, those who had one item correct, and those who failed both items. Against each of these three categories are references to the appropriate sections of three different sets of resource materials.

For example, class 20 was tested in January 1980 on Objective 256. "Identify a conclusion either supporting or not supporting details of a passage". The three students getting only one item of the test correct may be referred by the teacher to an Audio Reading Progress Laboratory, Grade 5, Lesson 9A; or to the Open Highway Reading Text, Section 5 of the teacher's manual, page 48 of the student reading text; or to a Barnell Loft reading booklet, C or D, on "Drawing Conclusions".

The teacher examines the sections of the report relating to different objectives in order to make up a prescription for each student in the class.

At the present time, all teachers in the school use the test results to develop prescriptions of this kind. In an earlier phase of the project, when some teachers did not use the system, it was found that the performance of their students on the Canadian Test of Basic Skills was invariably below that of other students of the same age group who were assumed to have an equal or lower mean level of ability. These results gradually convinced teachers of the value of using prescriptions.

However, it should be noted that the management system does not presume to make judgments for teachers: it merely supplies the information from which they may make their own decisions. This has been an important factor in persuading members of staff that they are not being dictated to by a machine: they are merely being offered a very useful tool.

The class report is also used as a basis upon which to draw together smaller groups of students who have common problems in reading skills. Students with similar requirements can be identified and grouped quickly, and their needs can be met immediately by instruction from the teacher.

3. School Report

A summary of the reading performance of all students tested is available immediately following each period of testing, and is kept updated as individual tests are administered. All objectives are listed by number, they are briefly described, and against each is given the number of students who "do not know", "need to review", or "know" that objective. For example, following the testing in January 1980 of all students from Grade 2 to Grade 6, the first objective listed was #114, the first for the second grade level; and the last was #297, the last objective for the sixth grade level. Results were as follows:

		DO NOT KNOW	NEED TO REVIEW	KNOW	TOTAL
#114	Identify a word that ends with the same sound as two picture words:/b/	3	3	55	61
#297	Classify a passage as description, narration or exposition	28	29	3	65

In each case the total is the number of students who attempted the test for that objective.

This report is used by all the teachers in the school. A copy is posted in the staff room, and individual teachers study the results for the objectives relevant to their own classes. The report may be used to identify the areas of strengths in reading skills; but it is particularly used to identify current weaknesses, and to determine what skills need to be emphasized. This helps members of staff to direct their teaching appropriately, and indicates to them and the administration what types of reading materials it will be useful to bring into the school.

It should be emphasized that, in large measure owing to the use made of the school summary, the testing is never followed by teaching of reading skills in isolation. The skills are taught in all content areas.

Social studies, for example, includes the writing of reports in which emphasis is laid upon those skills found to be relatively weak in the school. Emphasis might be placed upon skills such as picking out a main idea and finding supporting details; identifying details not related to the main topic; and putting events into chronological order.

The librarian makes use of information from the school summary when giving book talks to small groups of students, or when talking to larger groups on more general topics.

In effect, the class teachers use individual and class reports to guide their teaching of reading to meet students' personal requirements; and all members of staff use the school report to direct their efforts to areas of more general need. The effect has been to make reading into a matter of general education in the school, and it has produced excellent results.

6. RESULTS

Objective evidence regarding the improvement of reading achievement in the school is provided by scores on the Canadian Test of Basic Skills. These tests are given at the beginning and end of each school year. Mean scores for the Reading Vocabulary and Comprehension sections of the test, obtained by Grades 6, 5 and 4 in May 1977 and May 1979, are given in Table 1. For each grade in each year, the number of students is in excess of 100.

TABLE 1

Mean Scores on Canadian Test of Basic Skills

	May 1977		May 1979	
Grade	Vocabulary	Comprehension	Vocabulary	Comprehension
6	3.9	4.0	6.5	6.5
5	2.8	2.7	5.4	5.4
4	3.2	3.9	4.6	4.8

All 1979 means are markedly higher than 1977 means; and the 1979 means for Grade 4 are higher than the 1977 means for Grade 6.

If a comparison is made with mean scores obtained in May 1974, when the project was in the planning stage but not yet in operation, the differences are much more marked. For Grade 6 at that date, the mean Vocabulary score was 2.1 and the mean Comprehension score was 3.5.

Before the project began, the mean reading score for the school as measured by the Canadian Test of Basic Skills, stood at the twenty-fifth percentile for the Calgary Board of Education schools. It now stands at the fifty-fifth percentile.

It should be noted that, in Table 1, the 1977 Grade 4 and the 1979 Grade 6 are the same age group of students tested at the beginning and the end of a two year period. During two years, therefore, they gained 3.3 years (i.e. 6.5 - 3.2) in Vocabulary and 2.6 years (i.e. 6.5 - 3.9) in Comprehension.

Reading the 1977 figures from the bottom to the top of Table 1, it is clear that students did not at that time maintain continuous progress in reading: Grade 5 means were lower than Grade 4 means. By 1979 the situation had changed and the figures suggest even progress through the grade levels for both Vocabulary and Comprehension.

In the second year of the project a small controlled experiment was carried out. An experimental group was selected consisting of the 32 poorest readers in Grade 6, as measured by the Canadian Test of Basic Skills Reading Vocabulary section. A control group was obtained by randomly selecting 32 subjects from among the remaining students in Grade 6. For the experimental group, teaching materials and procedures were related entirely to the CMI system. The control group received the normal program of the school. A comparison of the mean gains over a period of eight months showed a significant difference in favor of the experimental group which was significant at the .001 level for both vocabulary and comprehension.

Attitudes of students towards use of the terminals have always been very positive. Attitudes of teachers towards the management system were initially somewhat cautious and reserved. Following the first testing and the production of reports which were obviously useful, however, teachers' attitudes became progressively more positive. As indicated earlier, all members of staff now use the system on a regular basis and are fully committed to a reading program based upon the CMI printouts.

Attitudes in the community are very positive indeed. At the beginning of the third phase of the project in June 1979, a questionnaire was sent to all parents requesting a statement of their attitude towards use of the computer based system. Of 368 questionnaires distributed, 275 were returned; and of these, 260 were in favor of continuing the system, 6 were against, and 9 were neutral. Typical comments were: "It would be a great loss to our children's education if the program was discontinued"; and "The computer provides a much needed tool to aid children in developing reading skills, assessing problems in reading, and allowing for more personalized remedial help in overcoming any reading problems. Perhaps the present program will lay the groundwork for better understanding of individual learning. I hope it may be possible in future to see computer time used to help evaluate and correlate data used in planning more personalized courses in other areas such as math."

7. CAI PROGRAMS

The improvement in reading achievement and the positive attitudes of all constituencies affected by the project have led to further developments of the program. The most significant of these is the progressive introduction of CAI over a period of six years, using programs designed and written by the two specialist reading teachers.

Use was made of the results from the criterion referenced tests in the CMI system, also from the Canadian Test of Basic Skills and Stanford Diagnostic and Achievement Tests. These indicated that the most able readers, that is those with highest reading comprehension, had a good understanding of syllabication skills, vocabulary, roots and affixes, and inflectional endings. Conversely, low reading comprehension scores were related to poor skills in the same areas. It was therefore apparent where the greatest needs were for CAI programs.

The instructional procedures used in the programs were based upon the experience of the two specialist teachers relating to a variety of approaches to the teaching of reading at different grade levels. Both tutorial and drill and practice modes were used. It was important, since the programs were to teach reading skills, to keep vocabulary at the level of students needing remediation. Programs were paced, moving students along a continuum of reading skills by using their current strengths. Reinforcement was provided in the form of positive statements regarding the student's present achievements, and by including clues to encourage further effort.

The resulting programs are now used to supplement the regular reading program, and form part of the prescriptions referred to earlier. They cover basic syllabication skills, roots and affixes, inflectional endings, synonyms, homonyms, word classification, compound words, and other vocabulary development skills.

Some programs are embedded in their own management system. For example, the syllabication program has a format consisting of a pre-test, instruction, drill and practice, and a post-test. A management system controls student progress through the programs, generates reports on student performance, and provides certain statistical analyses (Wontner, 1978). A similar management system is used with some of the programs teaching vocabulary, inflectional endings, the use of plurals including plural possessives, tense, and comparatives.

It is anticipated that the CAI programs will be extended to teach progressively more of the reading skills in the future.

8. RESEARCH AND PRACTICE

It may now be said that, in the case of the elementary school in which the project began, the research and development which has taken place during the last six years has led to a stage of practical application. The total reading program of the school is now centred around the CMI system.

The system has also been adopted as part of an ongoing program in one other elementary school which has a teacher competent to bring it into successful operation. Other elementary schools, a junior high school and a senior high school make use of the system, without making it the basis of a complete reading program.

At the present time, therefore, the transition from research to practice is on a comparatively small scale, but well founded. Rapidly reducing costs of hardware could make such a system much more readily available to schools in the future. The most important factor inhibiting the use of CMI will be the shortage of qualified personnel. Throughout this paper there has been frequent emphasis on the crucial role of the two specialist teachers who supervise the operation of the system in the school, and facilitate its use as an integral part of the ongoing instruction.

An important task still to be undertaken, therefore, is staff development. A comprehensive series of in-service programs to meet the specific needs of teachers, administrators and support staff is required to acquaint them with the various aspects of CMI and CAI. The provision of such programs will most appropriately be undertaken by project staff such as the two specialist teachers, and will obviously require an additional time allotment.

A further important consideration is the need for on-going research and development which will continue to be channelled into practice. Within a few months, a system parallel to that used for reading will be in operation for number skills. Thereafter, it is hoped to experiment with the introduction of a multi-media terminal for use with the students in Kindergarten and Grade 1. Several other developments are needed in the management system itself, and many more CAI programs could be used.

Again, a condition of further research and development is the presence in the school of teachers competent to engage in such work. The experience gained in this project gives ample evidence that the future of CMI and CAI in public schools lies in the area of teacher education.

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